CLAIMS

1. A method of manufacturing an oriented film by forming a blend of at least two polymers P1 and P2, which both are at least partly crystalline at a temperature below 100°C, whereby P1 has a mechanically determined melting point which is at least 20°C higher than the mechanically determined melting point of P2, extending the blend to form a film and stretching the film, whereby the polymers are selected such that they exist as separate phases in the stretched film, and P2 in its unoriented state at 20°C exhibits a coefficient of elasticity (E) which is at least 15% lower than E of P1, and oriented film comprises an alloy of the polymer which is a dispersion of fibrils of P1 surrounded by P2, whereby each fibril extend mainly in one direction and generally has width and thickness which as a mean of these two dimensions is around or lower than 5μm, and further stretching of the film partly takes place by draw-down after extrusion of film while both components are at least partially molten, and partly at a later stage <u>characterised in that</u> the film after said draw-down is hot stretched while P1 is in solid state and P2 is substantially molten to selectively orient P1, such that the elongation at break in the direction of said hot stretching, at least 25% this hot stretching being carried out by drawing the film over a frictionally withholding device.

2. A method according to claim 1, <u>characterised in that</u> after said hot stretching the film is further stretched while both components P1 and P2 are solid, in such a manner that the product film has an elongation at break at 20°C (by slow drawing) of at least 25% in any direction.

3. A method according to claim 1 or claim 2, <u>characterised in that</u> the fibrils are flat with average thickness generally around or lower than 1 μm, preferably generally around or below 0.5 μm, and more preferably generally around or lower than 0.1 μm, and with average width is generally around or lower than 5 μm.

4. A method according to claim 1, <u>characterised in that</u> in order to reduce the cross dimensions of the fibrils, the molten blend during extrusion

is passed through at least one screen or grid located in a chamber immediately upstream of the exit orifice of the extrusion device, said chamber having a gap higher than the gap of the exit orifice.

5. A method according to claim 4, characterised in that each such grid has walls extending several millimetres in the direction of the flow of the molten blend.

6. A method according to claim 5, characterised in that the major walls in each such grid are slanted so that each forms an angle between about 10 to about 70° to the major surface of the flow entering the grid.

7. A method according to claim 6, characterised in that the slanting and the wall thickness and distances between the walls are such that in a longitudinal section of the device perpendicular to major surface of the flow as this enters the grid, there are at least four such walls.

8. A method according to claim 6, characterised by at least two grids, where in the such walls of one grid are slanted in the opposite direction to the walls of the other grid.

9. A method according to claim 1, characterised in that in succession to the extrusion and attenuation of the blend while both P1 and P2 are molten, the film is first cooled to solidify P1 and P2, thereafter the film is heated in air-lubricated engagement with a heating body of controlled temperature to melt or at least partially P2, while keeping P1 solid, and immediate thereafter, while P2 still is at least partially molten and P1 is solid, the film is subjected to the said selective orientation of P1 and subsequent solidification of P2.

10. A method according to claim 1, characterised in that the frictional is withholding device comprises one or more bars with rounded edges over which the film is dragged while following an adjustable arc of the bar edge, and said bar or bars are maintained at a temperature which prevents the film from sticking to the edge or edges, and the length of travel in contact with the edge or edges is adapted to prevent P2 wholly solidifying.

11. A method according to claim 9, characterised in that at least the process steps from and including extrusion to and including the solidification of P2 are carried out in-line, whereby the line also comprises a hold-back device acting between the cooling and the subsequent heating, and preferably the process steps following solidification of P2 are also carried out in-line with the former process steps.

12. A method according to claim 11, characterised in that the film is extruded as a flat film, and the controlled hold-back between cooling and subsequent heating is established by a roller arrangement, which also may supply the said cooling.

13. A method according to claim 11, characterised in that the film is formed and treated in tubular form from extrusion and at least to the final solidification of P2, whereby the controlled hold-back between cooling and subsequent heating is established by one or more circular rings with rounded edges over which the film is dragged while following an adjustable arc of the rounded edge, and said ring or rings are maintained at a temperature which prevents the film from sticking to the said edge or edges.

14. A method according to claim 11, characterised in that the said heating is carried out with the film in air-lubricated engagement with two heating bodies of which is provided one on each side of the film, the spacing between said heating bodies preferably being adjustable.

15. A method according to claim 1, characterised in that the film immediately after the extrusion is cooled to solidification of P1 while P2 is kept molten or semimolten, and further in immediate succession, the selective orientation of P1 over a frictionally withholding device is carried out with the polymers in such states.

16. A method according to claim 15, characterised in that the frictionally withholding device comprises one or more bars with rounded edges over which the film is dragged while following an adjustable bow-length of the edge, and said bar or bars and the length of travel in contact with the edge or edges is adapted to prevent P2 wholly solidifying.

17. A method according to claim 15, characterised in that the cooling to the said state is carried out by air-lubricated engagement of the film with a cooling body of controlled temperature.

18. A method according to claim 17, characterised in that the cooling is carried out with the film in air-lubricated engagement with two heating bodies, one on each side of the film, the spacing between said heating bodies preferably being adjustable.

19. A method according to claim 2, characterised in that the said further stretching is carried out in the same longitudinal direction as the hot stretching of the film.

20. A method according to claim 19, characterised in that by a suitable selection of the conditions for the different stretching processes, and optionally by addition of a finely dispersed fracture-promoting material to the extruded blend, the longitudinal orientation after full solidification is adapted to produce locations of rupture of the P1 fibrils and in connection with such rupture extra orientation of P2 in and around the said locations, the locations being generally extended in a linear fashion at an angle to the direction of orientation.

21. A method according to claim 19, characterised in that the said further stretching is carried out at around 50°C or at a lower temperature.

22. A method according to claim 19, characterised in that in succession to said further stretching, transverse stretching is carried out while P1 and P2 are solid, preferably under allowance of a simultaneous longitudinal contraction.

23. A method according to claim 22, characterised in that longitudinal contraction is achieved by forming transverse pleats in the film prior to the transverse stretching, and the latter is carried out by means of a tenter frame.

24. A method according to claim 2, characterised in that the said further stretching is carried out transversely of the preceding longitudinal

orientation of the film, preferably while the film is allowed to shrink in said longitudinal direction.

25. A method according to claim 24, characterised in that the shrinking is achieved by forming transverse pleats in the film prior to the transverse stretching, and the latter is carried out by means of a tenter frame.

26. A method according to claim 1, characterised in that a minor surface layer is coextruded on at least one side of the blend to enhance bonding properties and/or modify frictional properties of the film.

27. A method according to claim 1, characterised in that P1 consists of polypropylene polyamide or polyethylene terephthalate, and P2 mainly consists of a propylene copolymer or polyethylene.

28. A method according to claim 27 in which said polypropylene is a crystalline copolymer of propylene.

29. A method according to claim 27 or 28 in which the polyethylene is a crystalline copolymer of ethylene, preferably linear low density polyethylene.

30. A method according to claim 1, characterised in that after the end of the mentioned steps, the film, which exhibits a uniaxial or unbalanced orientation, is laminated to one or more similarly or differently manufactured films of uniaxial or unbalanced biaxial orientation, whereby the films are arranged so that their main directions of orientation cross each other.

31. A method according to claim 1, characterised in that additionally to the mentioned steps the film is cut into narrow longitudinally oriented tapes.

32. A method of forming a film or sheet of thermoplastic polymer alloy in which there is formed an intimate blend of polymer material P1' and polymer material P2', the blend is extruded through a die, in which the flow passage through the die comprises an exit orifice having an exit gap, characterised in that upstream from the exit orifice there is provided a grid chamber comprising one or more grids through which the blend passes, the

grid or grids having apertures of a size selected to reduce the average size of the dispersed phase of P1' or P2' in the blend, the grid or grids being located at a position in the chamber where the gap is wider than the said exit gap, the grid chamber further comprising a gap reduction portion between the screen and the die exit wherein the gap through which the blend flows is reduced at least part way to the gap of the die exit.

33. A method according to claim 32, characterised in that the or each such grid has walls extending several millimetres in the direction of the flow.

34. A method according to claim 33, characterised in that the major walls in each such grid are substantially planar and are slanted so that each forms an angle between about 10 to about 70° to the major surface of the blend flow entering the grid.

35. A method according to claim 34 characterised in that the said angle and the wall thickness and distances between the walls are such that in a longitudinal section of the die perpendicular to the major surface of the blend flow as this enters the grid, there are at least four such walls.

36. A method according to claim 34, characterised by at least two such grids which mutually are oppositely slanted in relation to the direction of the blend flow entering the grid.

37. A method according to claim 32, characterised in that there is coextruded a surface layer at least on one side of the blend flow, preferably before this flow meets the grid or grids.

38. A method according to claim 32, characterised in that P1' and P2' are incompatible to such an extent that they exist as separate phases in the final film, but are compatibilised either by use of an alloying agent or mechanically by sufficient mixing and attenuation, and P2' in its unoriented state at 20°C exhibits a coefficient of elasticity (E) which is at least 15% lower than E of P1', and preferably but not necessarily the mechanically determined melting point of P1' is at least about 20°C higher than that of P2', and further by adaptions of rheological conditions, percentages of the

components, and conditions for mixing and extruding a dispersion of microscopically fine fibrils or fibril network of P1' surrounded by P2' is formed in the alloy, whereby each fibril extends mainly in one direction and generally has a thickness around or lower than 5µm, preferably around or lower than 1µm, and still more preferably around or lower than 0.1µm and width at least 5 times it thickness, and further characterised in that the film is stretched after at least P1' has been solidified.

39. A method according to claim 38, characterised in that the said stretching is transverse to the direction of the fibrils, and preferably the film is allowed to contract in the direction of the fibrils during said stretching.

40. A method according to claim 38, characterised in that possibilities for contraction are introduced by a preceding fine transverse pleating of the film.

41. A method according to claim 40, characterised in that the step of stretching transverse to the direction of the fibrils is preceded by stretching in the direction of the fibrils while the latter are solid.

42. A method according to claim 38, characterised in that P1' consists of polypropylene, polyamide or polyethylene terephthalate, and P2' mainly consists of a propylene copolymer or polyethylene.

43. A method according to claim 42 in which the polypropylene is a crystalline copolymer of propylene.

44. A method according to claim 42 or 43 in which the polyethylene is a copolymer of ethylene, preferably linear low density polyethylene.

45. A method according to claim 38, characterised in that the film is given a strong uniaxial or unbalanced biaxial orientation, and subsequently the film is laminated to one or more similarly or differently manufactured film of uniaxial or unbalanced biaxial orientation, whereby the films are arranged so that their main directions of orientation cross each other.

46. A method according to claim 38, characterised in that subsequently the film is cut into narrow longitudinally oriented tapes.

47. A method according to claim 32, characterised in that P1' is chosen to exhibit desirable barrier properties, and P1' and P2' are incompatible to such an extent that they exist as separate phases in the final film, but are compatibilised either by use of an alloying agent or mechanically by sufficient mixing and extension, and preferably but not necessarily the mechanically determined melting point of P1' is at least about 20°C higher than that of P2', and further by adaptions of rheological conditions, percentages of the components, and conditions for mixing and attenuation is formed in the alloy as whereby each fibril extends in one main direction, has a thickness around or lower than 5µm, preferably around or lower than 1µm, and has a width at least 5 times its thickness.

48. A method according to claim 32, characterised in that P1' and P2' are incompatible to such an extent that they exist as separate phases in the final film, but are compatibilised either by use of an alloying agent or mechanically by sufficient mixing and extrusion and preferably but not necessarily the mechanically determined melting point of P1' is at least about 20°C higher than that of P2', and further by adaptions of rheological conditions, percentages of the components, and conditions for mixing and attenuation a dispersion of microscopically fine fibrils or fibril network of P1' surrounded by P2' is formed in the alloy, whereby each fibril extends mainly in one direction, has a thickness around or lower than 5µm, preferably around or lower than 1 µm, and has width at least 5 times its thickness, and further characterised in that there is added a volatile expansion agent prior to or during the extrusion, which agent is soluble in P2' but generally not in P1', whereby expansion is takes place after extrusion.

49. An extruded oriented film comprising a layer of alloy of at least two polymers P1 and P2, which both are at least partly crystalline at temperatures less than 100°C, wherein P2 in its unoriented state at 20°C exhibits a coefficient of elasticity (E) which is at least 15% lower than E of P1, and the alloy comprises a dispersion of microscopically fine fibrils or fibril network of P1 surrounded by P2, wherein each fibril extends mainly in

one direction and generally has width and thickness wherein the mean of these two dimensions is around or lower than 5μm, characterised in that

a) the P1 fibrils are flat and generally parallel with the main surfaces of the film with thicknesses generally around or lower than 1 μm and width at least 5 times the thickness, and/or

b) the oriented film exhibits locations of rupture of the P1 fibrils, which locations extend in a generally linear fashion at an angle to the direction of orientation.

50. A film according to claim 49, characterised by a minor coextruded surface layer on at least one side of the alloy layer to enhance bonding properties and/or modify frictional properties of the film.

51. A film according to claim 50, characterised in that P1 consists of polypropylene polyamide or polyethylene terephthalate, and P2 mainly consists of a propylene copolymer, or polyethylene.

52. A film according to claim 51 in which the polypropylene is a crystalline copolymer of propylene.

53. A film according to claim 51 in which the polyethylene is a copolymer of ethylene, preferably linear low density polyethylene.

54. An extruded film according to claim 49 which is laminated to another oriented film, whereby the main directions of orientation cross each other.

55. A film according to claim 49 in the form of rope, twine or woven-tape products.

56. An extruded film comprising a layer of an alloy of at least two polymers P1 and P2, which both are at least partly crystalline at temperatures under 100°C, wherein P2 in its unoriented state at 20°C exhibits a coefficient of elasticity (E) which is at least 15% lower than E of P1 comprising a dispersion of microscopically fine fibrils or fibril network of P1 surrounded by P2, wherein each fibril extends mainly in one direction, characterised in that the fibrils of P1 are flat and generally parallel with the main surfaces of the film with thicknesses generally around or lower than 1

μm, and width at least 5 times the thickness, and further characterised in that P1 is chosen to exhibit desirable barrier properties.

57. A film according to claim 56, characterised by a minor coextruded surface layer on at least one side of the alloy layer to enhance bonding properties and/or modify its frictional properties.

58. A film according to claim 5, characterised in that P1 consists of EVOH, vinylidene chloride polymers or polyamide.

59. An extruded film according to claim 56 which is uniaxially or biaxially oriented and is laminated to another oriented film, whereby the main directions of orientation cross each other.

60. A cellular expanded film made by extrusion in the presence of an expansion agent, characterised in that the film is made from an alloy of at least two polymers P1 and P2, which both are at least partly crystalline at temperatures under 100°C, the alloy comprising a dispersion of microscopically fine fibrils or fibril network of P1 surrounded by P2, whereby each fibril extends mainly in one direction and is flat with thicknesses generally around or lower than 1μm, and width at least 5 times the thickness.

61. A film according to claim 60 which is uniaxially or biaxially oriented and is laminated to another film, whereby the main directions of orientation cross each other.

62. A film according to claim 60 in the form of rope, twine or woven-tape products.

63. A film according to claim 60 in the form of split fibre products.

64. A film according to any of claims 60 to 63 in which wherein P2 in its unoriented state at 20°C exhibits a coefficient of elasticity (E) which is at least 15% lower than E of P1.

65. A film according to any of claims 56 to 65 in which P2 is a copolymer of propylene or polyethylene, preferably a copolymer of ethylene and another alphaolefin, preferably LLDPE.

66. A film according to any of claims 56 to 66, in which, in the alloy, the weight proportion of P1 is in the range 5 to 75 % preferably 20 to 50%.

67. Apparatus for extruding thermoplastic material comprising a die having an exit orifice through which the molten material flows and stretching means for stretching the material after it is extruded by at least two steps, in the first of which the material is stretched longitudinally by first stretching means whilst at a high temperature, and in the second of which the material is stretched longitudinally by second stretching means at a lower temperature, comprising also means for cooling the extruded material between the two stretching means, said cooling means comprising a frictional device arranged for contact with the extruded material, characterised by further comprising stretching means downstream from said second stretching means, and additional cooling means between said second stretching means and said further stretching means.

68. Apparatus according to claim 67 in which the said frictional device is provided with holes or is made of microporous metal for inwards or outwards passage of air whereby lubricating air is provided to control the friction between the device and the material.

69. Apparatus according to claim 67 or 68 comprising a shock cooling part upstream of the frictional device past which the extruded flow passes and which is cooled by a flow of cooling medium through its interior.

70. Apparatus according to claim 69 which further comprises heating means between the shock cooling means and the frictional device, for controlled heating of the material.

71. Apparatus according to claim 70 in which the heating means comprises a pair of fixed heating blocks arranged on opposite sides of the extruded material.

72. Apparatus according to any of claims 67 to 71 in which the die has a grid chamber upstream from the exit orifice comprising one or more grids through which the extrudate passes, the grid or grids being located at a position in the chamber where the gap is wider than said exit orifice gap, the grid chamber further comprising a gap reduction portion between the grid or

grids and the exit orifice wherein the gap is reduced at least part way to the gap of the exit orifice.

73. Apparatus for extruding thermoplastic material comprising a die having an exit orifice through which the molten material flows and stretching means for stretching the material after it is extruded by at least two steps, in the first of which the material is stretched longitudinally by first stretching means whilst at a high temperature, and in the second of which the material is stretched longitudinally by second stretching means at a lower temperature, comprising also means for cooling the extruded material between the two stretching means, said cooling means comprising a frictional device arranged for contact with the extruded material, characterised in that there is provided a grid chamber upstream from the exit orifice comprising one or more grids through which the extrudate passes, the grid or grids being located at a position in the chamber where the gap is wider than said exit orifice gap, the grid chamber further comprising a gap reduction portion between the grid or grids and the die exit wherein the gap is reduced at least part way to the gap of the exit orifice.

74. Apparatus according to claim 72 or 73 in which each such grid has walls extending several mm in the direction of the flow.

75. Apparatus according to any of claims 73 to 74 in which the major walls in each such grid are substantially planar and are slanted so that each forms an angle between about 10 to 70° to the major surface of the extrudate flow entering the grid.

76. Apparatus according to claim 75 in which said angle and the wall thickness and distances between the walls are such that, in a longitudinal section of the die perpendicular to the main surfaces of the extrudate flow as this enters the grid, there are at least four such walls.

77. Apparatus according to claim 75 or 76 which comprises at least two such grids which are slanted in opposite directions to one another.

78. Apparatus according to any of claims 67 to 77 comprising means for coextruding a surface layer at least on one side of the extrudate.

79. Apparatus according to any of claims 67 to 78 comprising means for transverse stretching of the extruded film downstream of the second stretching means.

80. Apparatus according to claim 79 in which upstream of the transverse stretching means there is a longitudinal pleating device, preferably comprising a pair of rubber belts between which the extruded material passes.

81. Apparatus according to any of claims 79 to 80, in which the transverse stretching means comprises a tenterframe including an oven.

82. Apparatus according to claim 81, in which said oven comprises fixed heated blocks arranged on opposite sides of the material, provided with heating means, preferably electrical heating means.

83. Apparatus according to claim 82, which further comprises a cooling block on at least one side of the material, downstream of the heating blocks, said cooling block being provided with a channel for passage of cooling air, preferably in which said channel is in fluid communication with the surface of the block facing the extruded material, by virtue of forming the cooling block from microporous metal.

84. Apparatus according to claim 82 or 83, in which said heating blocks are formed of microporous metal in fluid contact with channels for passage of heated air, whereby heated air exits the blocks from the surfaces facing the material passing therebetween, to lubricate passage of the material therebetween.

85. Apparatus according to any of claims 67 to 72, in which the further stretching means is a longitudinal stretching means and the apparatus preferably comprises pleating means for imposing transverse pleats in the material prior to said longitudinal stretching.

86. Apparatus according to claim 85, including a laminating station, in which a second sheet material is laminated to the extrudate, said laminating station preferably being upstream from the longitudinal cold stretching means.

87. Apparatus according to claim 86, in which the extrusion die is a circular die for extruding a tube of material, and which further comprises helical cutting means downstream of the said second stretching station, and upstream of the laminating station, in which the tube of material is helically cut and two plies of the extruded material are laminated to one another with their main directions of orientation arranged at an angle to one another.

88. Apparatus according to any of claims 67 to 86 in which the extrusion die is a flat die.